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Thesis

AN ANALYSIS OF SCIENCE ACTIVITIES APPEARING
IN GENERAL-SCIENCE WORKBOOKS

Submitted by

Richard Stanley Byers

(B. S. in Ed., Boston University, 1943.)

In partial fulfillment of requirements for
the degree of Master of Education

1946

First Reader: Roy O. Billett,
Professor Education

Second Reader: G. Lawrence Rarick,
Assistant Professor of Science Education

Third Reader: J. Wendell Yeo,
Associate Professor of Education

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CHAPTER I

THE PROBLEM AND SCOPE OF THIS STUDY

The problem and Related Research

The statement of the problem.-- This study is an analysis of general-science workbooks and the textbooks they accompany to determine the relative frequency with which classroom activities are used to illustrate principles of science. An analysis of each activity, experiment or demonstration that involves using apparatus or equipment is considered in this study.

Considerable research has been done to determine the amount of space allotted to presenting an understanding of the basic principles of science in textbooks. Also much work has been done in determining the number of principles presented in various general-science textbooks.

Merely exposing a pupil to a scientific principle does not necessarily place this knowledge where the pupil may use it in solving problems that arise later. He must be given an opportunity to see the principle at work. This is borne out in a book on science instruction by Elliot Downing.^{1/} He states,

1/ Elliot R. Downing, *An Introduction to the Teaching of Science*, University of Chicago, Chicago, 1934, p. 9.

Principles are nearly universal; specific problems are local in both place and time. It seems wise than, to give a pupil such an understanding of the important principles of science and so much drill in solving problems occurring in the recall of such principles and in applying them when needed to solve his specific life problems.

The laboratory demonstration is one way of presenting to the pupil a concrete experience utilizing the fundamentals of a scientific principle. Victor Noll^{1/} in his textbook on the teaching of science says, "One of the most effective methods of bringing home to a class the meaning and importance of scientific law and generalization is through the use of a suitable and well-prepared demonstration."

The Thirty-first Yearbook of the National Society for the Study of Education^{2/} sees the need for not one illustration of a principle, but as many as the time allows.

The principles express fundamental truths in science that are general in their significance. Their development in different communities and in different sections of the country will differ only in illustrations used. If only a minimum amount of time is available, but a few illustrations will be used to develop the principles. On the other hand, if more time is provided, illustrations may be multiplied, thus enlarging the understanding of relationships and meaning expressed, which in turn will give an enriched appreciation to the natural environment.

Research related to this study.-- A number of studies have appeared that are directly related to this investigation. A

1/Victor H. Noll, The Teaching of Science in Elementary and Secondary Schools, Longmans, Green and Company, New York, 1939, p. 44.

2/National Society for the Study of Education, Committee on the Teaching of Science, A Program for Teaching Science, Thirty-first Yearbook, Part I, Public School Publishing Company, Bloomington, Illinois, 1932, p. 177.

study by Wilbur L. Beachamp^{1/} is one of these. His study was devoted, in part, to a survey of 58 courses of study in general science to determine the prevailing practices in the teaching of science. He states,

The multitude of types of organizations shows very clearly the lack of a fundamental theory of education. Until educators and science teachers have clearly formulated an adequate theory of education it is probable that we may continue to expect chaos which now prevails in the organization of courses.

In the conclusion of the study he writes,^{2/}

A shift has occurred from the organization of courses in terms of topics and subtopics to organization around certain major ideas or concepts. These ideas may be generalizations or principles of science or important ideas underlying the understanding and control of certain phases of man's environment.

Teacher and pupil demonstration has replaced individual experimentation to a marked degree in the junior high school. A great increase in the use of the demonstration is also observable in the specialized science courses.

Beachamp showed that there was at least an attempt to organize courses around basic principles of science. Downing^{3/} set out to discover if the textbooks used in general-science courses were organized in this manner or not. To accomplish this task a study of twenty general-science textbooks was made. A master list of principles found in the various texts was drawn up and it was discovered that no book

^{1/}Wilbur L. Beauchamp, Instruction in Science, Bulletin, 1932, No. 17, National Survey of Secondary Education, Monograph No. 22, United States Government Printing Office, Washington, D.C., p. 26.

^{2/}Ibid. p. 62-63.

^{3/}Elliot R. Downing, "An Analysis of textbooks in General Science", General Science Quarterly, (May, 1928) 12: 509-516.

exceeded a 12 per cent representation of the total list of principles. Therefore, he concluded that no book is built upon principles.

A little later study is in complete agreement with the findings of Downing. Wilbur^{1/} made a study of textbooks published since 1924 to select the major principles around which science courses are built. He found 170 principles listed in the various books. Eighteen were given only in part in more than half the textbooks. He concluded,

General-science textbooks vary widely as to the number of acceptable principles contained The authors of these general-science texts are not in close agreement with themselves as to what principles of science are most important in a general-science course.

The general-science textbooks analyzed in this investigation do not seem to have been organized in terms of principles of science.

These studies have shown the position of the basic principle in textbooks. Davis^{2/} made an analysis of general-science textbooks from the subject-matter viewpoint. He examined eight textbooks for the subject-matter contained rather than the number of principles that could be found. If a subject-matter topic appeared in 75 per cent of the textbooks then it was retained. The results gave him 137 topics. He therefore concluded, "There is a high

1/Oliver B. Wilbur, A Study of the Principles of Science Contained in General-Science Textbooks Published since the Beginning of the Year 1924, Unpublished Master's Thesis, University of Michigan, 1931.

2/Ira C. Davis, "Analysis of the Subject Matter in Eight most Widely used Textbooks in General Science," School Science and Mathematics, (June, 1931) 31:707-714.

agreement in textbooks for the units: air, water, heat, weather and climate, light, magnetism and electricity, energy and machines, plants, the human body, and foods."

The results of this investigation demonstrates clearly that our leading textbooks in general science do agree on subject-matter content.

A study by Milton Klegman^{1/} was in part devoted to the determination of the relative emphasis which was placed upon various topics in workbooks. His method was to tabulate the number of pages devoted to each topic and the average percentage of pages devoted to each topic was shown. Klegman's^{2/} findings are presented here because his study is most comparable to the writer's investigation.

Table I. The Average Percentage of the Total Pages which are Devoted to Each Topic in 14 Work-books.

Topic	Average Percentage
Care and Understanding our Bodies	16.
Man in his Changing World	15.
Heat and Fire	11.
Electricity and Magnetism	10.
Plants and Animals	9.
Water	7.

^{1/}Milton A. Klegman, An Analysis of Workbooks in General Science, Unpublished Master's Thesis, University of Washington, 1940, p. 43-44.

^{2/}Klegman, op. cit., p. 25.

Table I (cont.)

Topic	Average Percentage
Light	6.
Air and Other Gases	6.
Solar System	6.
Weather and Climate	5.
Earth's Surface	5.
Sound	3.
Miscellaneous	1.
Total	<u>100.</u>

In his conclusions Klegman^{1/} states, "In the comparison of the emphasized topics of the workbooks with those found in courses of study, textbooks and other curriculum studies, it is found that there is a comparable close agreement....With respect to the comparison of the emphasized topics of the workbooks with those found in teacher practices in the state of Washington, a similar close agreement is found."

These reviewed studies have shown that there is need for courses in general science to be built around the basic principles of science, but textbooks used in these courses are not so constructed. Instead, textbooks are based upon subject-matter topics. A similar study by Klegman^{2/} involving workbooks found

^{1/}Klegman, op. cit., p. 44.

^{2/}Klegman, Loc. cit.

the same to be true. In the light of the previous research, this study is devoted to an analysis of general-science workbooks and the accompanying textbooks to determine the relative frequency with which classroom activities are used to illustrate principles of science.

Methods of Procedure

Procedure for selecting the books analyzed in this study.--

To select the textbooks and their accompanying workbooks, the following question was asked at the salesrooms of several reliable publishers in the vicinity of Boston: "What textbook do you recommend for a ninth-grade general-science course? I want one which has a workbook and one that does not presuppose the pupil to have had work with any other books in its series for successful teaching." The book so recommended to fulfil all these requirements was used in the study. Seven publishers had such books available.

Following is a list of the workbooks and the textbooks used in this study with the key to the guide by which they will be recognized throughout this study.

List of books used in this study.

- A. Unzicker, Samuel P., and Gruenberg, Benjamin C.
ACTIVITIES IN GENERAL SCIENCE. Yonkers-on-Hudson: World Book Company, 1939. 202 p. \$0.76.
- Gruenberg, Benjamin C., and Unzicker, Samuel P.
SCIENCE IN OUR LIVES. Yonkers-on-Hudson: World Book Company, 1938. 754 p. \$1.80.
- B. Hunter, George W., and Whitman, Walter G.
LABORATORY EXERCISES FOR SCIENCE IN OUR WORLD OF PROGRESS. Boston: American Book Company, 1935. 232 p. \$0.60.

List of books used in this study. (Concluded).

- Hunter, George W., and Whitman, Walter G.
SCIENCE IN OUR WORLD OF PROGRESS. Boston:
 American Book Company, 1935. 581 p. \$1.87.
- C. Beauchamp, Wilbur L.; Mayfield, John C.; and
 West, Joe Young. A STUDY-BOOK FOR EVERYDAY
 PROBLEMS IN SCIENCE. New York: Scott, Foresman
 and Company, 1940. 346 p. \$0.63.
- Beauchamp, Wilbur L.; Mayfield, John C.; and
 West, Joe Young. EVERYDAY PROBLEMS IN SCIENCE.
 New York: Scott, Foresman and Company, 1940.
 752 p. \$1.29.
- D. Watkins, Ralph K., and Bedell, Ralph G.
WORKBOOK TO GENERAL SCIENCE FOR TODAY. Boston:
 Macmillan Company, 1937. 179 p. \$0.64.
- Watkins, Ralph K., and Bedell, Ralph C.
GENERAL SCIENCE FOR TODAY. Boston: Macmillan
 Company, 1937. 715 p. \$1.91.
- E. Wood, George C., and Carpenter, Harry A.
SCIENCE DISCOVERY BOOK. Boston: Allyn and
 Bacon, 1940. 311 p. \$0.96.
- Wood, George C., and Carpenter, Harry A.
OUR ENVIRONMENT, HOW WE USE AND CONTROL IT.
 Boston: Allyn and Bacon, 1940. 810 p. \$1.92.
- F. Curtis, Francis D. WORKBOOK FOR EVERYDAY SCIENCE.
 Boston: Ginn and Company, 1943. 179 p. \$0.88.
- Caldwell, Otis W., and Curtis, Francis D. EVERY-
 DAY SCIENCE. Boston: Ginn and Company, 1946.
 664 p. \$1.96.
- G. Love, Curtis, and Clark, John A. WORKBOOK FOR
 SCIENCE ON THE MARCH. Boston: Houghton, Mifflin
 Company, 1944. 268 p. \$0.78.
- Clark, John A.; Fitzpatrick, Frederick L.; and
 Smith, Edith Lillian. SCIENCE ON THE MARCH.
 Boston: Houghton, Mifflin Company, 1944. 618 p.
 \$1.96.

Procedure for analyzing the books.-- The workbooks were first inspected for all science activities that could be carried on in the classroom. These are both demonstrations and experiments; but, for the purpose of this study the work activities will be used to denote both. This study is also limited to activities which involve the usage of some apparatus or equipment. This eliminates all activities which use only pencil and paper and also those which are limited to discussion.

The method of compiling and classification of this material was patterned after the method used in a study by Cureton^{1/} and the method advised by Dr. Roy O. Billett.

Each activity was written on a 3 by 5 card, coding in the upper left-hand corner the source of the item and a topical classification. An example of one of these cards is presented below.

I 26
W (water)

When will an object float on water?

A body will float when its weight is less
than the weight of the fluid it displaces.

^{1/}Edward E. Cureton, "Junior High School Science", School Review, (December, 1927) 35:767-775.

The heading of the activity was reproduced in the same form as in the book. These were found to be questions or statements. After reading the activity a note was placed on the card telling the most important principle or understanding that the activity actually illustrated. If an activity was a direct contributing factor toward the understanding of a principle, the principle was so noted. The number of activities, each represented by a card, according to workbooks and textbooks is as follows:

Table 2. The Number of Activities Which Appeared in Workbooks and the Number Which Appeared in the Textbook but not in the Workbook.

Books Examined	Number of Activities in Workbooks	Number of Activities in Text but not in Workbook	Total
A	227	17	244
B	67	15	82
C	140	40	180
D	101	61	162
E	81	58	139
F	123	15	138
G	138	46	184
Totals	<u>877</u>	<u>252</u>	<u>1129</u>

These cards were then classified into thirteen divisions under the following topical headings.

Care and Understanding of our Bodies

Man in his Changing World

Heat and Fire

Electricity and Magnetism

Plants and Animals

Water

Light

Air and Other Gases

Solar System

Weather and Climate

Earth's Surface

Sound

Miscellaneous

The cards in each of these divisions were then classified into the following groups: (a) contributing to the understanding of a principle, (b) presenting an understanding but not a direct contribution to a principle, (c) things and processes to observe, and (d) things to make.

In order to make a comprehensive determination of principles it is necessary to set up a list of criteria for a scientific principle. Wilbur^{1/} in his study used the following:

A principle of science is a comprehensive generalization which:

1. Is stated positively and definitely;

1/Oliver B. Wilbur, A Study of the Principles of Science, Contained in General-Science Textbooks Published Since the Beginning of the Year, 1924. Unpublished Master's Thesis, University of Michigan, 1931.

2. Is true with but rare exceptions within the limitations set up by the statement;
3. Clearly states or implies a dynamic process or interaction;
4. Is demonstrable experimentally;
5. Is clearly not a part of a larger principle which can be definitely stated;
6. It is not merely a definition or a description.

Wise^{1/} in his study set up a similar list of criteria.

To be a principle a statement must be a comprehensive generalization describing some fundamental process, constant mode of behavior or property relating to natural phenomena.

It must be true without exception within limitations specifically stated.

It must be capable of illustration.

It must not be a definition.

For purposes of classification the following list of criteria, adapted from the above lists will be used in this study.

A principle must be:

1. A positive and definite statement of a process;
2. True with but rare exceptions;
3. Capable of illustration;
4. Free from the tages of a definition or description.

The findings of this study are presented on the basis of these criteria after consideration of the methods and procedures as stated.

^{1/}Harold E. Wise, "A Determination of the Relative Importance of Principles of Physical Science for General Education", Science Education, (December, 1941) 25:371.

CHAPTER II

FINDINGS OF THIS STUDY

On the following pages the findings of this study are presented as an aid for interpretation. The tables are prepared to show the principles and understandings, things and processes to observe, and things to make, that were found to be illustrated by activities in the books analyzed.

Table 3. Frequency with which Certain Principles, Understandings, Things and Processes to Observe, and Things to Make Pertaining to the topic Water were found in Seven Workbooks and Accompanying Textbooks in General Science.

Items Found	Workbooks and Text- books Analyzed							Number of Activi- ties	Number of books in which ac- tivity appeared
	A	B	C	D	E	F	G		
I. Principles and Understand- ings.									
1. A body in a fluid is buoyed up by a force equal to the weight of the fluid dis- placed.	3	2	3	4	4	4	5	25	7
2. a. Evaporation from a body cools the evaporating body	3	2	5	2	2		1	15	6
b. Rate of evapora- tion depends upon temperature, area of surface, humi- dity of surround- ing air and motion of the air.	1		6					7	2
3. Fluids move from an area of high pressure to an area of lesser pressure.	3		2	1	2	1	4	13	6
4. Water pressure in- creases with depth and this pressure is exerted equally in all directions.	3	2			4	1	2	12	5
5. Liquids tend to seek their own levels.	1		2	1	1	2	3	10	6
6. Pressure applied to a confined liquid is transmitted undimi- nished throughout the fluid.		1				1	2	4	3

Table 3. (continued)

Items Found	Workbooks and Text- books Analyzed							Number of Activi- ties	Number of books in which ac- tivity appeared
	A	B	C	D	E	F	G		
7. If pressure on the surface of water is reduced it will boil at a lower temperature.	2			2				4	2
8. Dissolved substances diffuse equally throughout the solvent.	1						1	2	2
9. The solubility of a substance in water depends upon the substance and the temperature of the water.	2							2	1
10. When two solutions of different concentrations are separated by a membrane, a greater pressure will be developed on the side of higher concentration due to osmotic pressure.						2	1	3	3
11. When a solute is added to a solvent the boiling point of the solvent is raised.			1					1	1
12. Harmful impurities in water can be removed by precipitation, filtration, and distillation.	3		3	6		2	4	18	5
13. Water is "hard" because of dissolved minerals which can be removed by precipitation or by boiling.	1	1	2	1	1	3		9	6

Table 3. (continued)

Items Found	Workbooks and Text- books Analyzed							Number of Activities	Number of books in which ac- tivity appeared
	A	B	C	D	E	F	G		
14. A saturated solution of a crystalline substance tends to form crystals.		1	3	4				8	3
15. Water is a compound of hydrogen and water.	2			2	1	2		7	4
16. Evaporation of water from plants and bodies of water places it in the air.		2	1			1	3	7	4
17. Water enters plants by osmosis and leaves by evaporation.	4				2			6	2
18. Water expands upon freezing.	1		1	1		1		4	4
19. Some substances are dissolved easier in other solvents than in plain water.	2		2					4	2
20. Water is an important solvent and medium for chemical reaction.		3	1					4	2
21. Water can exist as a solid or a liquid at 32° F. and as a solid or a gas at 212° F.			3			1		4	2
22. Hot water tends to rise.			2	1				3	2
23. Water is found in air.	2					1		3	2
24. Water is found in soil.					2	1		3	2
25. By capillary action the smaller the inside diameter of a tube the higher the fluid will rise.	1			1				2	2

Table 5. Frequency with which Certain Principles, Understandings, pertaining to the topic Heat and Fire were found in Seven Workbooks and Accompanying Textbooks in General Science.

Items Found	Workbooks and Text- books Analyzed							Number of Activities	Number of books in which ac- tivity appeared
	A	B	C	D	E	F	G		

I. Principles and Understand- ings.									
1. To obtain combustion, a combustible substance must reach the kindling temperature in the pre- sence of oxygen.	9	2	10	7	6	3	2	39	7
oxidation of iron	1		2		1	1	1	6	5
fireproofing with chemicals		1						1	1
2. In general, matter ex- pands when heated and contracts when cooled.	5		3		5	3	1	17	5
Substances expand at different rates.	2							2	2
3. A dark dull surface absorbs heat; a shiny surface reflects heat.	2	1			1		3	7	4
4. Heat is distributed by conduction, con- vection, and radia- tion.	5		4	1	5	5	6	26	6
Insulation	1				1		1	3	3
5. The burning of fuels releases carbon diox- ide and moisture in- to the atmosphere..	1		1	3	1	3	1	10	6
6. Decaying matter, ani- mals and sometimes plants release car- bon dioxide into the atmosphere.	1				1	2		4	3

Table 5. (continued)

Items Found	Workbooks and Text-books Analyzed							Number of Activities	Number of books in which activity appeared
	A	B	C	D	E	F	G		
4. Heat is used in industry for:									
Obtaining metals from ore	1	1			1	2		5	4
Making coke and coalgas	1	1	1	2				5	4
Making charcoal and gas			1	1				2	2
Making quicklime	1							1	1
5. The flame of a burning fuel is composed of gas which has reached its kindling temperature.	2			1				3	2
6. Some substances such as magnesium will increase in weight by burning because of the addition of oxygen.	1		1					2	2
7. Thermometers are used for an accurate measuring of heat in degrees.	1					1		2	2
8. Heat is a form of energy.	1							1	1
9. The sources of heat are friction, electricity, burning, and the sun.	1							1	1
10. Carbon is found in some form in all fuels.		1						1	1
11. An explosion is rapid burning.	1							1	1
12. A large amount of water will absorb more heat than will a small amount of water.				1				1	1

Table 6. Frequency with which Certain Principles, Understandings, Things and Processes to Observe, and Things to Make pertaining to the topic, Plants and Animals, were found in Seven Workbooks and Accompanying Textbooks in General Science.

Items Found	Workbooks and Text- books Analyzed							Number of Activities	Number of books in which ac- tivity appeared
	A	B	C	D	E	F	G		
I. Principles and Understand- ings.									
1. All life comes from life and reproduces its own kind, every individual differing from each other.	9	2	1	8		3	7	30	6
2. Most plants need sun- light and air to make their food.	4	2	3		3	2	4	18	6
3. All living matter is composed of cells.	2		2	6	1		4	15	5
4. Living things by their life activities affect the welfare of other living things.		1	2	2	1	2	5	13	6
5. Plants and animals re- quire water and air to survive.	4	1	2	1	1		2	11	6
6. Bacteria grow best in warm, moist places.	1				1	4		6	3
7. Bacteria are present in huge numbers in our surroundings.			1	1	1		2	5	4
8. The earthworm will re- act to stimuli.	3							3	1
9. Mold is a type of living plant.					1			1	1

Table 7. Frequency with which Certain Principles, Understandings, Things and Processes to Observe, and Things to Make pertaining to the topic Man in his Changing World were found in Seven Workbooks and Accompanying Textbooks in General Science.

Items Found	Workbooks and Text- books Analyzed							Number of Activities	Number of books in which ac- tivity appeared
	A	B	C	D	E	F	G		

I. Principles and Understand- ings.									
1. In a physical change the molecules remain the same; in a chemi- cal change the mole- cules are changed.	3	2	2	5		3	7	22	6
2. a. Steam, gas, and oil engines are able to change heat energy into mechanical energy.	4	4	2	1	2		5	18	6
b. Centrifugal force is used to regulate the speed of the steam engine.	1	1						2	2
3. The greater the fric- tion between two sur- faces the greater must be the force required to move them.	4	2		1	1	1		9	5
4. A change in rate or direction of motion of a body requires the application of an external force.	3	1		1				5	3
5. When work is done there must be both force and movement.	2					1	1	4	4
6. All matter occupies space and has weight.					1			1	1

Table 8. Frequency with which Certain Principles, Understandings, Things and Processes to Observe, pertaining to the topic Care and Understanding of our Bodies, were found in Seven Workbooks and Accompanying Textbooks in General Science.

Items Found	Workbooks and Text- books Analyzed							Number of Activities	Number of books in which ac- tivity appeared.
	A	B	C	D	E	F	G		
I. Principles and Understandings.									
1. All living things re- produce their own kind but each individual differs from other mem- bers of the class.	4	2	1	1	1		1	10	6
2. Foods contain various substances which can be tested for									
starch	1		2	2	1	1	2	9	6
sugar	3		1	1		2	1	8	5
fat	1		1		1	1	1	5	5
protein	1	1				1		3	3
carbohydrates (carbon)			1		1			2	2
minerals					1			1	1
water	1							1	1
adulterants					1			1	1
3. Bacteria cause food to spoil.			1		2		2	5	3
4. Pasteurized milk will remain "sweet" longer than will raw milk.					1	1		2	2
5. Types of fabrics can be determined by the length of their drying period, the odor when burning and their ap- pearance.						1	1	2	2
6. Vitamins are necessary to our diet.						1		1	1

Table 8. (continued)

Items Found	Workbooks and Text- books Analyzed							Number of Activities	Number of books in which ac- tivity appeared.
	A	B	C	D	E	F	G		
7. Alcohol breaks down protein.					1			1	1
8. Alcohol dissolves chlorophyll.					1			1	1
Subtotal								<u>52</u>	
II. Things and Processes to be Observed.									
A. Things to be Observed.									
1. A drop of blood.	1		1		1			3	3
2. Blood vessels and veins in fingers and in tail of a fish.		1			1	1		3	3
3. Nervous system of an animal.	2							2	1
4. Lungs of a higher animal.	1		1					2	2
5. Internal organs of a higher animal	1							1	1
6. Muscle of an animal	1							1	1
7. Joints of an animal			1					1	1
8. Kidney of an animal						1		1	1
9. Heart of an animal						1		1	1
B. Processes to be Ob- served.									
1. Digestion (effect of saliva and hydro- chloric acid on in- soluble starch)			3	1	1	1	1	7	5

Table 9. Frequency with which Certain Principles, Understandings, Things and Processes to Observe, and Things to Make Pertaining to the topic Light were found in Seven Workbooks and Accompanying Textbooks in General Science.

Items Found	Workbooks and Text- books Analyzed							Number of Activities	Number of books in which ac- tivity appeared
	A	B	C	D	E	F	G		
I. Principles and Understand- ings.									
1. Light travels in straight lines.	2		2		1	1	2	8	5
2. When light moves from one medium to another it is bent.	4	2	7	6	2	4	5	30	7
3. Light is reflected from a smooth sur- face at the same angle with the surface as it struck.	2		5	1		2	1	11	5
4. The intensity of light on an object diminishes as the distance increases from the source of the light.	1	1	1					3	3
5. We see because of reflected light.	2							2	1
6. Red light pene- trates better than does blue in fog and at night.		1						1	1
7. Light is absorbed by some substances and reflected by others.				1	2	1		4	3
8. Sunlight is com- posed of all the primary colors.	1		1	1		1		4	4

Table 9. (continued)

Items Found	Workbooks and Text-books Analyzed							Number of Activities	Number of books in which activity appeared
	A	B	C	D	E	F	G		
9. Blending of two primary colors produces a secondary color.	1							1	1
10. A luminous flame is found to contain many carbon particles.	1							1	1
11. Heat energy can be changed into light energy.	1							1	1
12. Light is measured by the unit candlepower.	1							1	1
13. Light is diffused from a rough surface.			1					1	1
14. Light can bring about a chemical change.			1					1	1
Subtotal								69	
II. Things and processes to be Observed.									
A. Things to Observe.									
1. Cow's eye.	1							1	1
2. Photographic paper (exposed)	1							1	1
3. Camera			2	2	2	1		7	4
4. View finder			1					1	1
5. Motion picture projector.				1				1	1

Table 10. Frequency with which Certain Principles, Understandings, and Things to Make pertaining to the topic Air and Other Gases were found in Seven Workbooks and Accompanying Textbooks in General Science.

Items Found	Workbooks and Text- books Analyzed							Number of Activities	Number of books in which ac- tivity appeared
	A	B	C	D	E	F	G		

I. Principles and Understand- ings.									
1. All matter (air) has weight and occupies space.	2		3	1	1	1		8	5
Because of this weight air exerts a pressure.	3		2	4	6	3	2	20	6
2. Pressure applied to a confined gas is exerted equally in all directions.	3			1				4	2
3. Fluids move from an area of high pres- sure to an area of lesser pressure.		2					1	3	2
4. A body will float if its weight is less than the weight of the dis- placed fluid.			1		1			2	2
5. When an inclined sur- face is in a moving body of air with the higher side facing in- to the moving body of air the surface tends to rise.		1		1	1		1	4	4
6. Air offers resistance to moving bodies.	2	2		1				5	3

Table 12. Frequency with which Certain Principles, Understandings, Things to Observe, pertaining to the topic The Earth's Surface were found in Seven Workbooks and Accompanying Textbooks in General Science.

Items Found	Workbooks and Text-books Analyzed							Number of Activities	Number of books in which activity appeared
	A	B	C	D	E	F	G		
I. Principles and Understandings.									
A. Principles									
1. The surface of the earth is continually changing.	4	1	3	2	1	3	2	16	7
B. Understandings									
1. The earth's interior is a solid.						1		1	1
2. Soil is composed of many kinds of matter.	2			1	2	1	1	7	5
3. Different proportions of ingredients in mixing artificial stone results in stones of varying strengths.	2	1			1	1		5	4
Subtotal								29	
II. Things to be Observed.									
1. Classification of rocks and minerals.	1	3	1	2		1	2	10	6
Total								39	

Table 14. Frequency with which Certain Principles, Understandings, Things to Observe, and Things to Make pertaining to the topic Weather and Climate were found in Seven Workbooks and Accompanying Textbooks in General Science.

Items Found	Workbooks and Text- books Analyzed							Number of Activities	Number of books in which ac- tivity appeared
	A	B	C	D	E	F	G		

I. Principles and Understand- ings.									
A. Principles									
1. Warm, moist air con- denses when it strikes a cool surface.	2		1	1	2	1	1	8	6
2. Evaporation from a body cools the evapo- rating body.		1	1		1	2		5	4
3. A sudden decrease of pressure over water causes fog or a cloud to form.		1		1		1	1	4	4
B. Understandings									
4. Air currents are caused by rising hot air.					1			1	1
5. Weather conditions con- trol the actions of some animals.					1			1	1
Subtotal								19	

II. Things to Observe.									
1. Weather maps			1			1	1	3	3
2. Weather balloons							1	1	1
3. Hair hygrometer							1	1	1

CHAPTER III

RESULTS AND CONCLUSIONS

Results of This Study

This study is a determination of the relative frequency with which classroom activities are used to illustrate principles of science. The results are limited, due to the arbitrary judgments in evaluating activities which occur when only one person's opinion is involved.

The study shows a total of 1127 activities found in the seven workbooks and accompanying textbooks. Of this total, 904 were found likely to be a direct help to the pupil, in illustrating or utilizing basic principles and understandings of science.

A total of 134 basic principles and understandings appeared in the seven workbooks and accompanying textbooks. Some facts on their distribution are shown below. Total number of principles and understandings found was 134.

	Number	Per cent. of total
Number that appeared in all of the seven series.	7	5
Number that appeared in six or more series.	25	19
Number that appeared in five or more series.	40	30

Table 16 is a numerical digest of the frequencies and percentages of activities appearing, that are related to the various

topics. The percentages presented indicate that nearly the same percent of activities are devoted to each topic in the various books. However, the total number of activities are quite different.

Table 17 is a comparison of the findings of the Klegman study with the findings of this study. The percentages are presented as an aid to interpretation.

Table 16. Frequencies and Percentages of Total Activities Which Appear Related to Certain Topics in Seven General-Science Workbooks and Accompanying Textbooks.

	Workbooks and Textbooks Analyzed										F		G		Total	
	A		B		C		D		E		Num- ber	Per cent	Num- ber	Per cent	Num- ber	Per cent
	Num- ber	Per cent	Num- ber	Per cent	Num- ber	Per cent	Num- ber	Per cent	Num- ber	Per cent						
Water	37	15	15	18	39	22	29	18	21	15	22	16	31	17	194	17
Electricity and Magnetism	37	15	12	15	23	13	23	14	24	17	22	16	10	5	151	13
Heat and Fire	37	15	17	9	23	13	17	10	23	17	19	14	17	9	143	13
Plants and Ani- mals	25	10	7	9	11	6	23	14	10	8	15	11	42	23	133	12
Man and His Changing World	26	11	12	15	11	6	12	7	6	4	8	6	24	13	99	9
Care and Under- standing our Bodies	23	9	5	6	16	9	7	4	16	12	11	8	18	10	96	9
Light	20	8	4	5	24	13	15	9	6	4	9	6	8	5	86	8
Air and other Gases	13	5	7	9	8	4	14	9	13	9	12	9	11	6	78	7
Sound	8	3	4	5	11	6	7	5	7	5	3	2	7	4	47	4
Earth's Surface	9	4	5	6	4	2	5	3	4	3	7	5	5	3	39	3
Solar System	7	3	0	0	7	4	3	2	1	1	5	3	6	3	29	3
Weather and Climate	2	1	4	5	3	2	4	2	5	4	5	3	53	3	28	2
Miscellaneous	0	0	0	0	0	0	3	2	3	2	0	0	0	0	6	1
Totals	244	99	82	102	180	100	162	99	139	101	138	100	184	101	1129	101

Table 17. The Average Percentage of the Total Activities Which Appear Related to Certain Topics as found by this study Compared to the Average Percentage of the Total Pages Related to the Same Certain Topics as found by the Klegman Study.

Topics	This Study		Klegman Study	
	Average Percentage	Number assigned in order of highest percentage	Average Percentage	Number assigned in order of highest percentage
Water	17	1	7	6
Electricity and magnetism	14	2	10	4
Heat and Fire	12	3	11	3
Plants and Animals	12	4	9	5
Man in his Changing World	9	5	15	2
Care and Understanding Our Bodies	8	6	16	1
Light	7	7	6	7
Air and Other Gases	7	8	6	8
Sound	4	9	3	12
Earth's Surface	4	10	5	11
Weather and Climate	3	11	6	10
Solar System	2	12	5	9
Miscellaneous	1	13	1	13

Conclusions of This Study

1. General-science books differ widely in the type and number of activities contained. This fact necessitates a careful evaluation of what is to be taught before selecting the books to be used.

2. A close agreement is not apparent between the amount of space allotted to topics as found by Klegman and the number of activities devoted to each topic as found by this study. This condition shows that in some cases a great deal of space has been allotted to a topic but there are few activities which are likely to develop important principles related to that topic. It may, therefore, be concluded that there is a need for the development of illustrative activities which can be used to develop certain principles and understandings.

3. A great number of activities can be found to illustrate most of the principles of science which are fundamental to science, understanding and application. There are enough such activities to make possible the construction of a workbook for use with any good general-science textbook. It seems that the total list of activities found in this study would be an excellent foundation for the selection of activities to be used in preparing a well balanced general-science workbook.

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